

calorimeter calibration

What is new on this approach? More clean conditions:

- single beam track, match required
- identify track using RICH ring
- single shower in EMCAL
- HCAL peds within 3σ , before - within 10 counts

data: pass 4a, before - pass 3

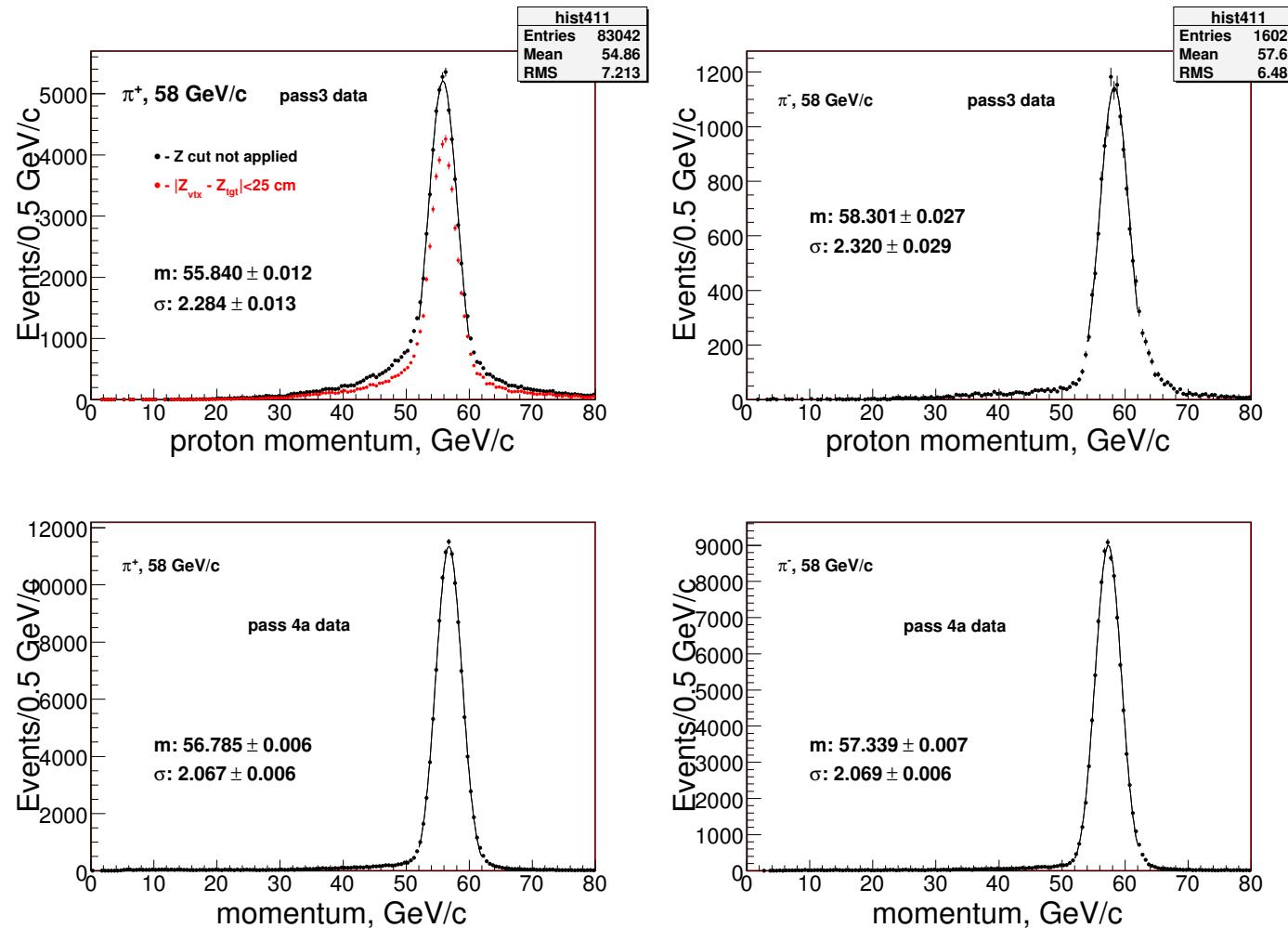
momentum: 58 GeV/c and 120 GeV/c for hadrons and 20 GeV/c for electrons

target: thin, LH2, empty

Event/track selection cuts:

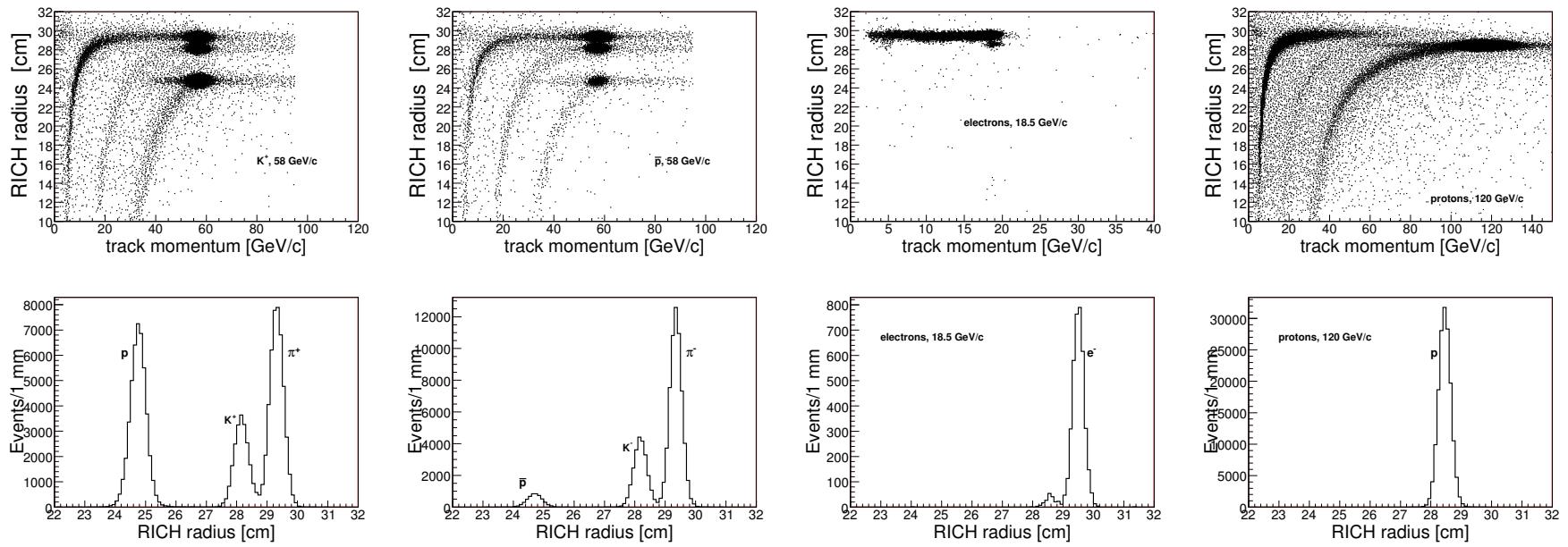
- $nTotalTrks \leq 20$
- vertices are within the target sizes (X and Y)
- $20 < NTPCPoints < 95$
- $-10 < TrkTime < 50$ ns
- tracks with the DC4, PWC5 and PWC6 hits
- only single track per event at HCAL aperture

momentum



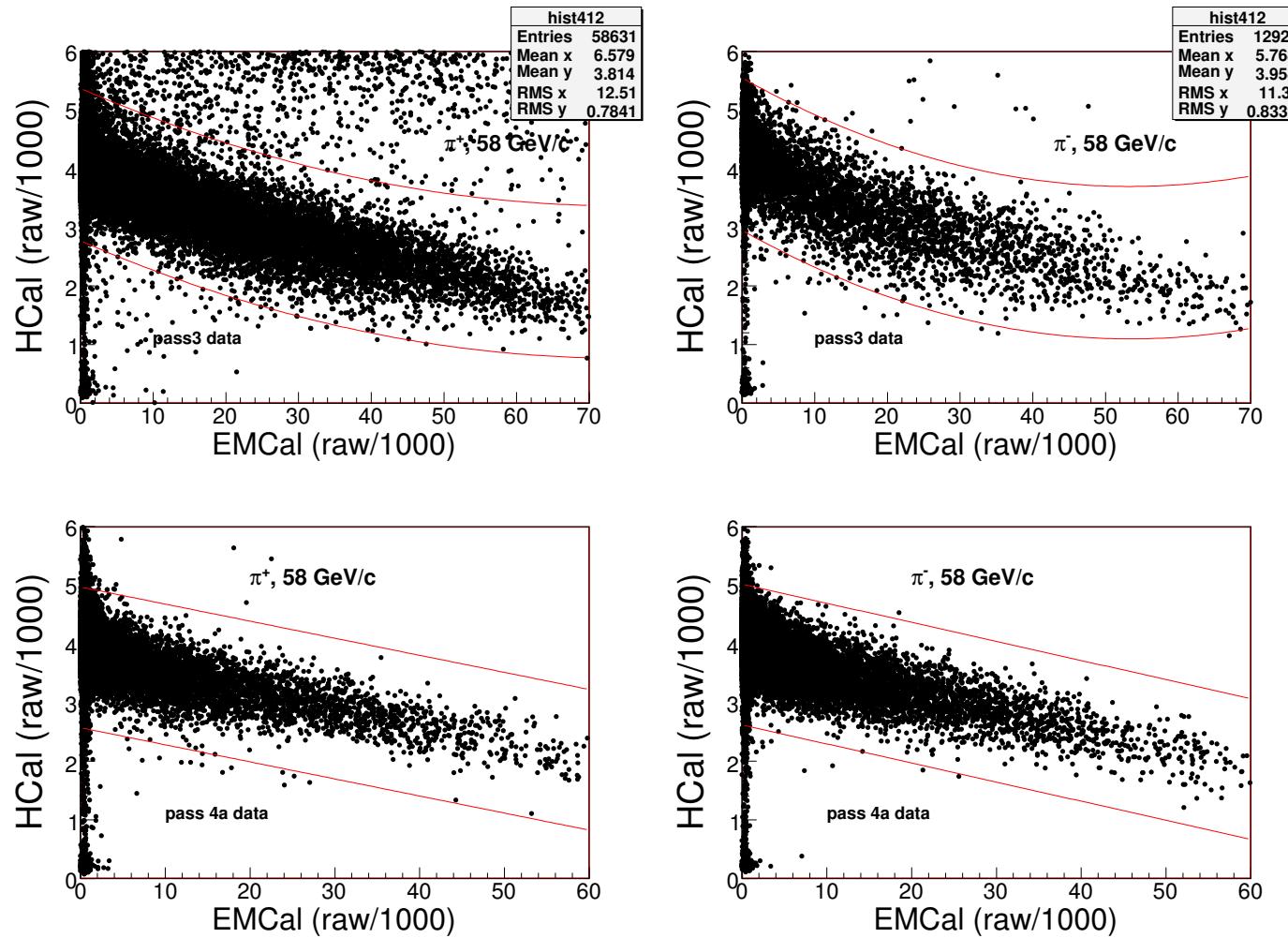
The pions momentum distributions. Top: pass 3 data, bottom - pass 4a. With current approach the peaks are cleaner, the widths are narrower. The momentum central values ($q > 0$ vs $q < 0$) now is closer .

RICH info



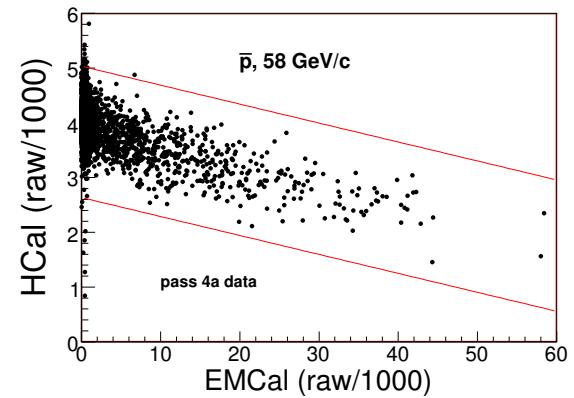
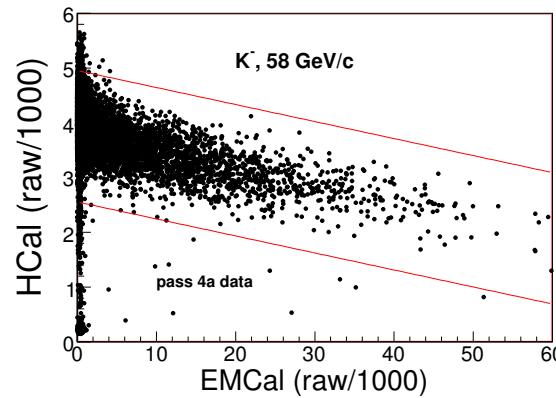
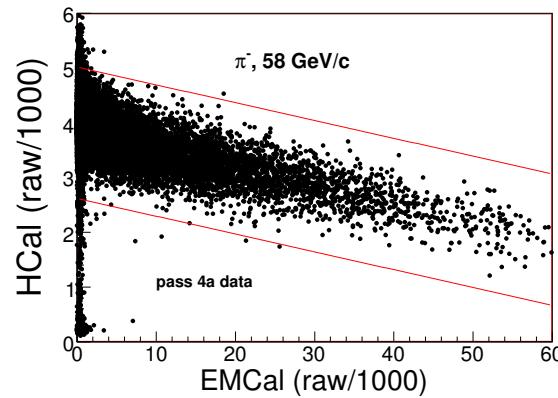
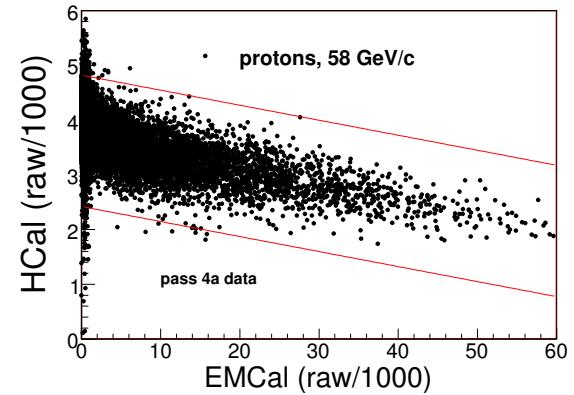
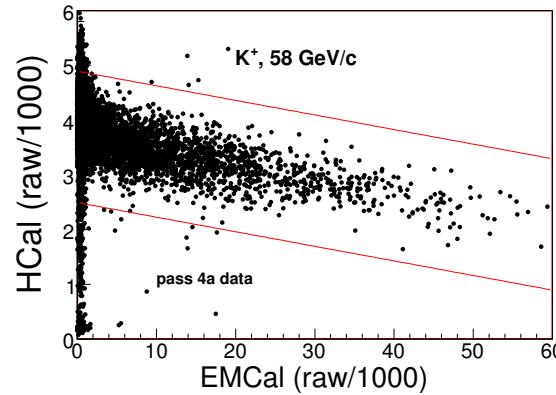
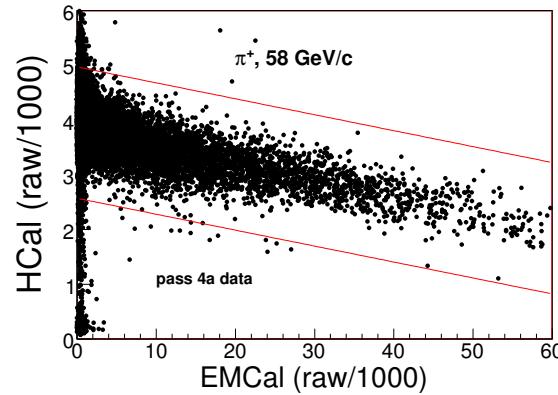
Top plots are the RICH radius vs the track momentum scatter plots: positive (most left) and negative (second column) 58 GeV/c hadrons, electrons (third column) and 120 GeV/c protons (most right). Bottom: RICH radius distributions with momentum cut: $p_o \pm 5$ GeV/c for 58 GeV/c hadrons, $p_o \pm 1.2$ GeV/c for electrons, $p_o \pm 14$ GeV/c for 120 GeV/c protons.

pass 3 vs pass 4a: HCAL vs EMCAL



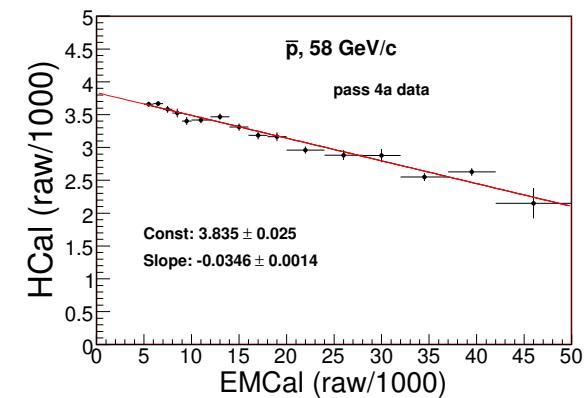
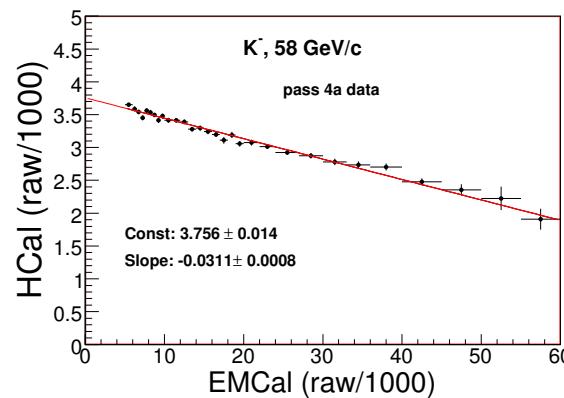
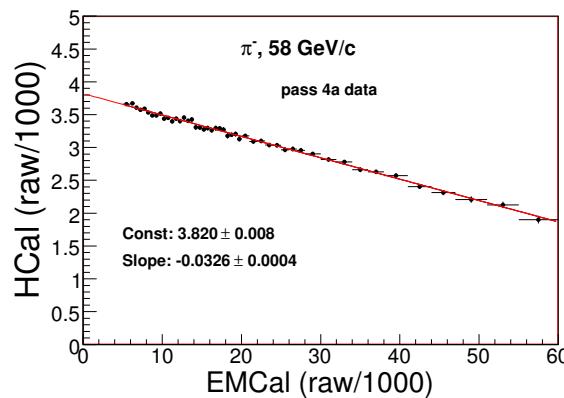
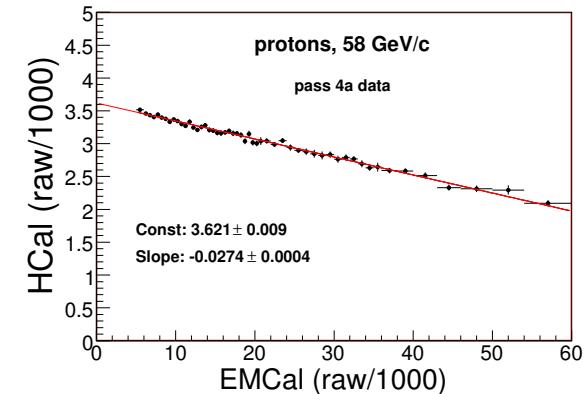
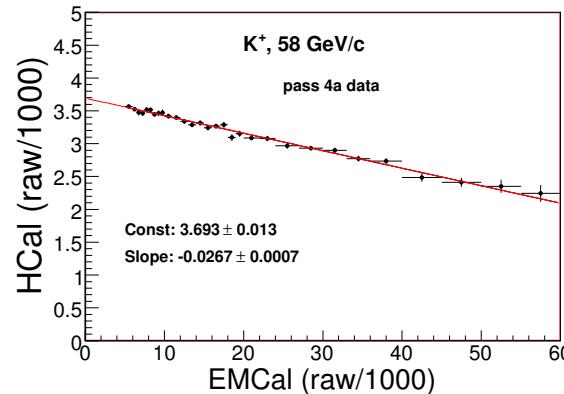
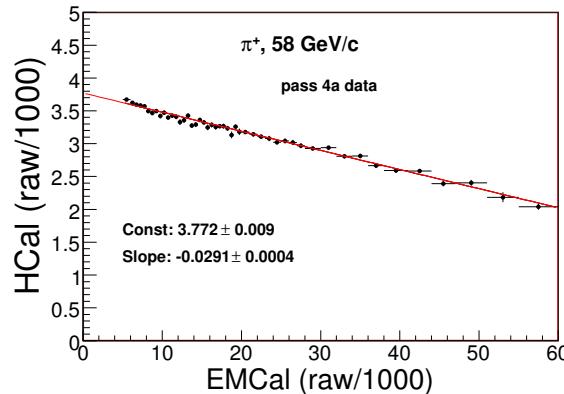
The HCAL vs EMCAL scatter plots for pions. Top: pass 3 data, bottom - pass 4a data. Bottom plots illustrate that the current approach is much cleaner.

HCAL vs EMCAL: raw ADC sum



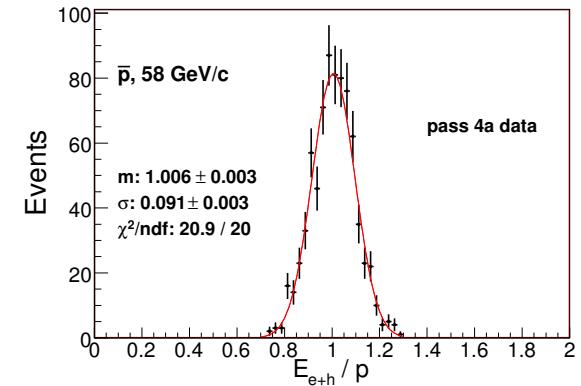
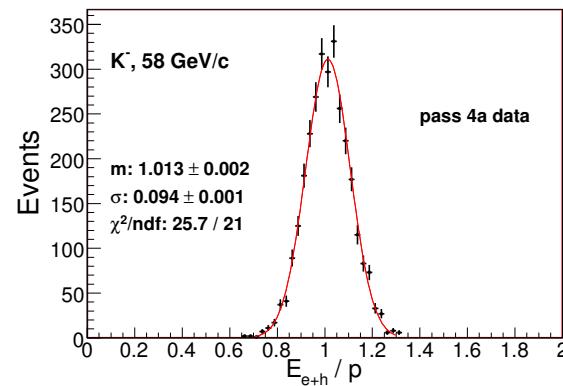
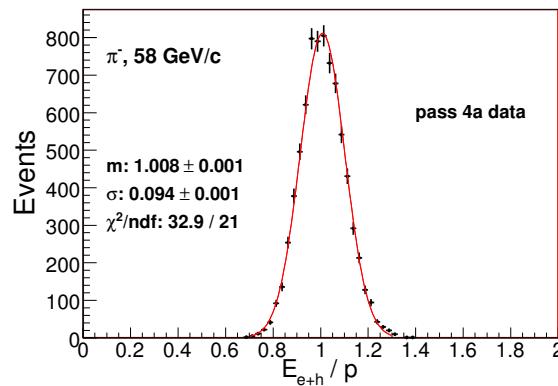
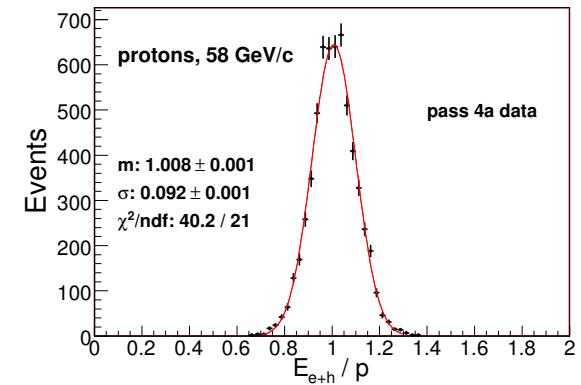
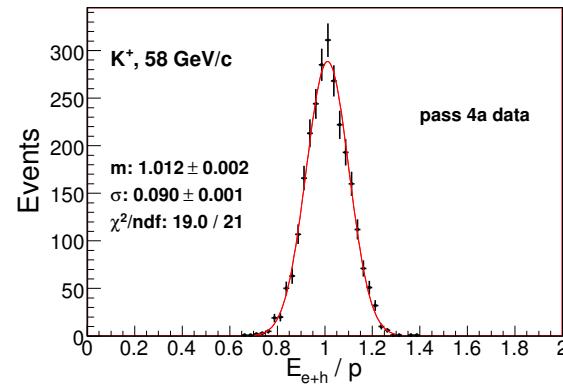
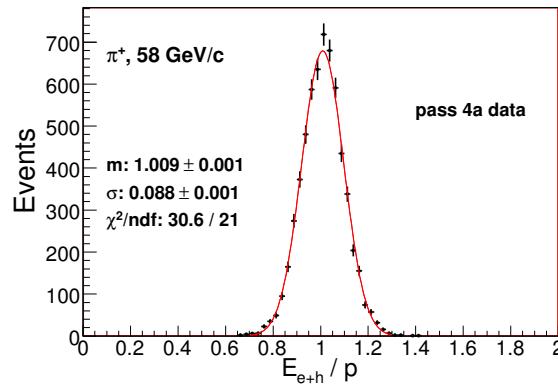
The HCAL vs EMCAL scatter plots for π^\pm (left plots), K^\pm (on middle) and p/\bar{p} (right plots). The red curves show the region within which events were used for the calibration purpose. The low statistics for \bar{p} plot is due to the rare yield in interactions.

HCAL vs EMCAL: fit profiles



The linear fit results of HCAL vs EMCAL profiles: π^\pm (left plots), K^\pm (on middle) and p/\bar{p} (right plots).

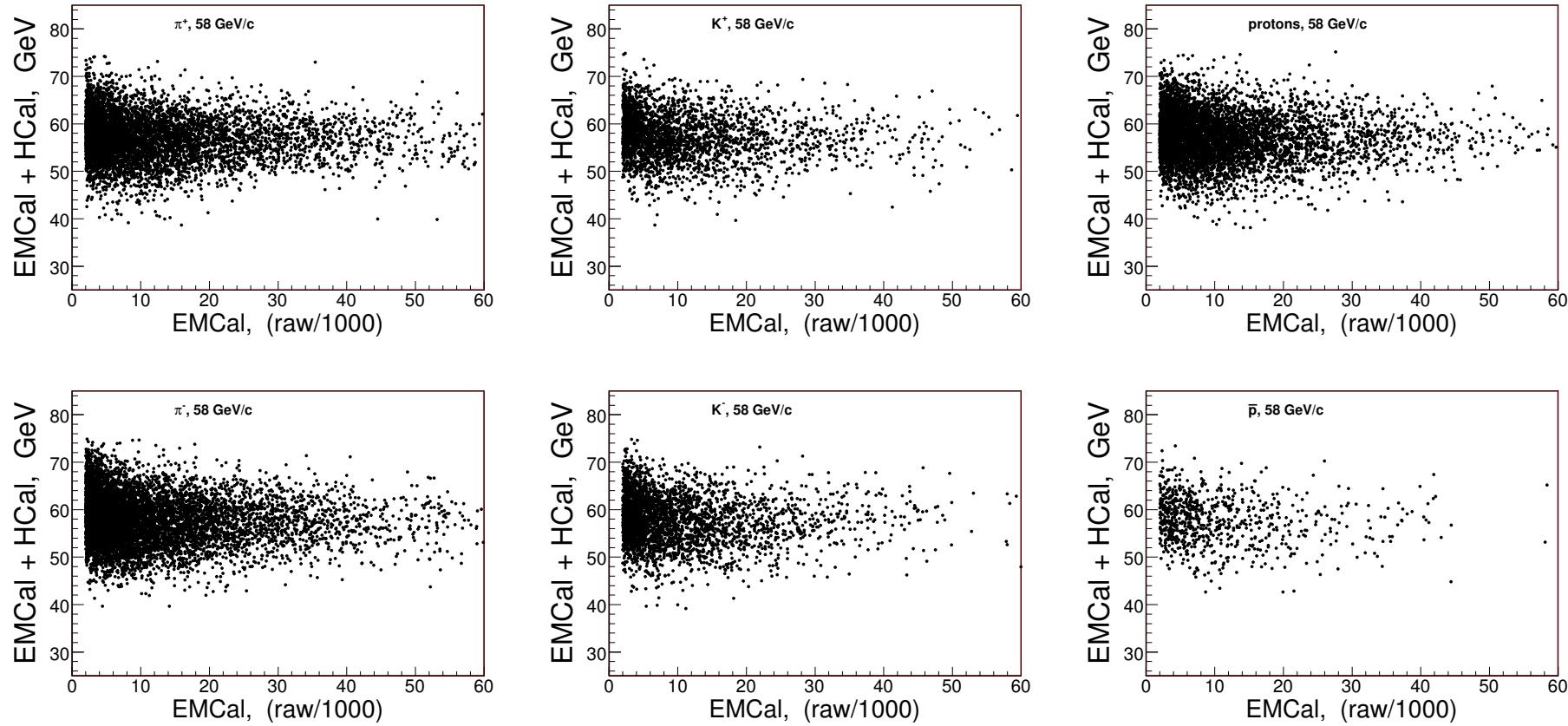
E_{e+h} / p ratio



The E_{e+h}/p ratio's for π^\pm (left plots), K^\pm (on middle) and p/\bar{p} (right plots). The E_{e+h} value was calculated as:

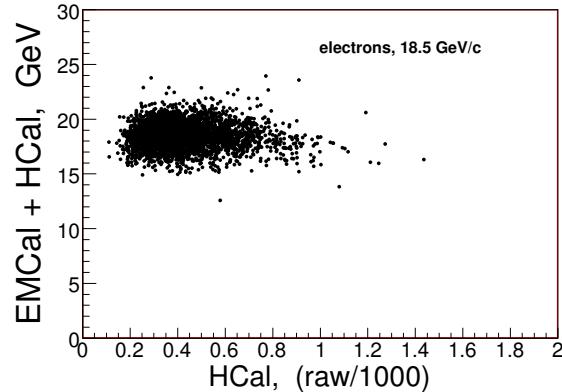
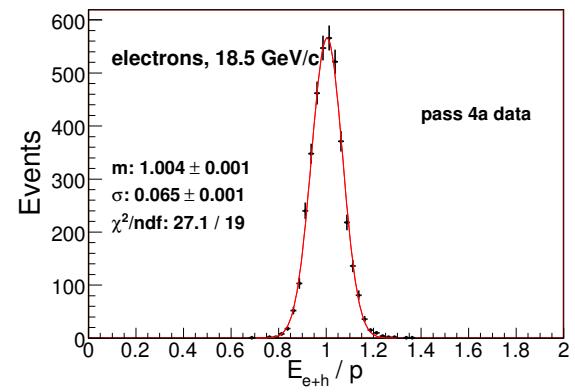
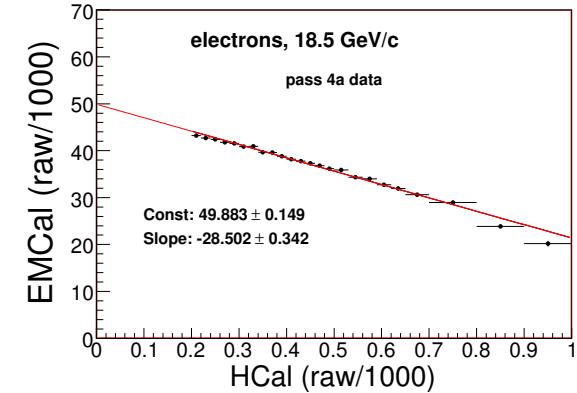
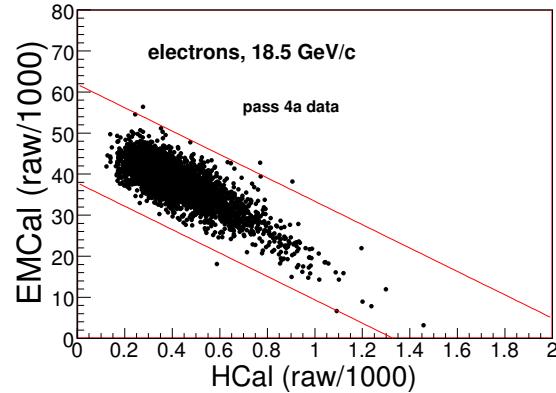
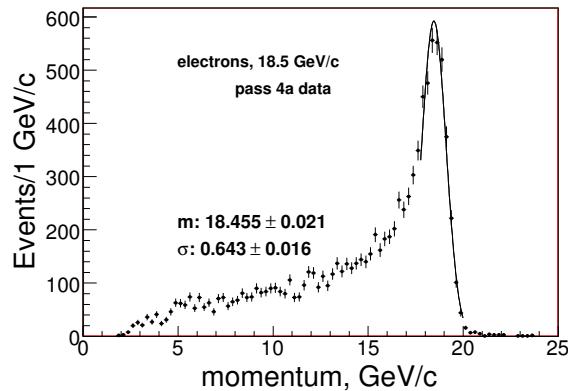
$$E_{e+h} = C_h \cdot \text{HCAL} + C_e \cdot \text{EMCAL}, \text{ where } C_h \text{ is a coefficient for HCAL and } C_e - \text{ for EMCAL.}$$

(EMCAL+HCAL) vs EMCAL



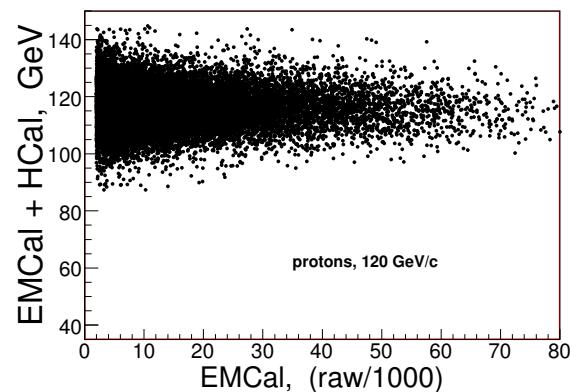
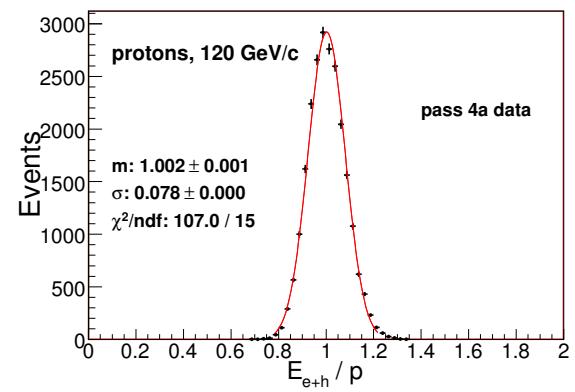
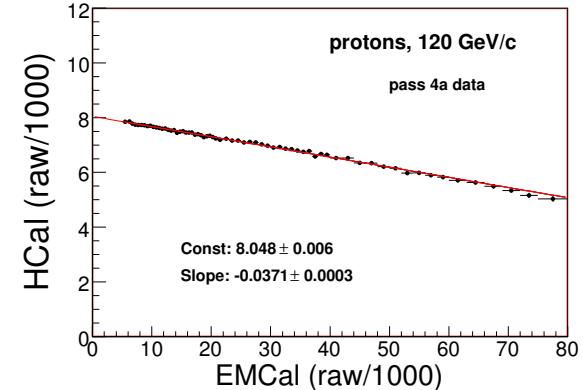
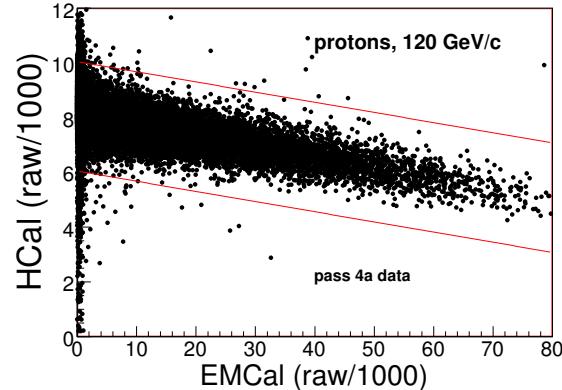
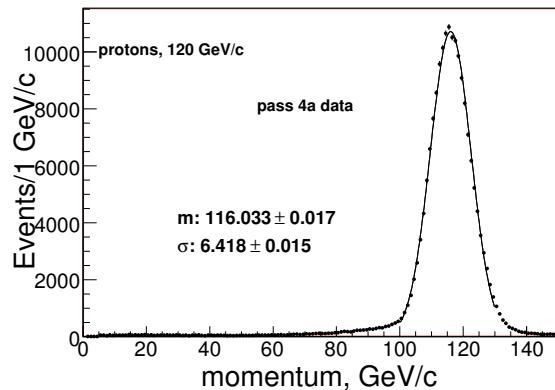
The (EMCAL+HCAL) vs EMCAL scatter plots for π^\pm (left plots), K^\pm (on middle) and p/\bar{p} (right plots). If calibration is done correctly, then the (EMCAL+HCAL) should not be dependent on EMCAL.

20 GeV/c electrons



20 GeV/c electron data plots. Top left - momentum distribution. Events within 17.2 - 20 GeV/c momentum range were used for calibration purpose. Top middle - EMCAL vs HCAL scatter plot. Top right - the linear fit of electron data. Bottom left - E_{e+h} / p ratio for electron data. Bottom right - the total vs HCAL counts.

120 GeV/c protons



120 GeV/c proton data plots. Top left - momentum distribution. Events within 116 ± 14 GeV/c momentum range were used for calibration purpose. Top middle - HCAL vs EMCAL scatter plot. Top right - the linear fit of proton data. Bottom left - E_{e+h} / p ratio. Bottom right - the total vs EMCAL raw counts.

energy coefficients and $\sigma_{E/p}$

	$C_h, (MeV)$	$C_e, (MeV)$	$\sigma_{E/p}$
e^-	10.57 ± 0.01	0.37 ± 0.01	0.065 ± 0.001
π^+	15.05 ± 0.04	0.438 ± 0.006	0.088 ± 0.001
π^-	15.01 ± 0.03	0.489 ± 0.006	0.094 ± 0.001
K^+	15.38 ± 0.05	0.41 ± 0.01	0.090 ± 0.001
K^-	15.26 ± 0.06	0.47 ± 0.01	0.094 ± 0.001
$p, 58 \text{ GeV}/c$	15.68 ± 0.04	0.430 ± 0.006	0.092 ± 0.001
$\bar{p}, 58 \text{ GeV}/c$	14.95 ± 0.10	0.52 ± 0.02	0.093 ± 0.003
$p, 120 \text{ GeV}/c$	14.42 ± 0.01	0.535 ± 0.004	0.078 ± 0.001

Table 1: Summary of the energy coefficients: 1st column - for HCAL, 2nd - for EMCAL. 3th column is $\sigma_{E/p}$.
 e/π^+ ratio: 0.84 ± 0.01 , e/π^- ratio: 0.75 ± 0.01

conclusions

- Single track, single shower requirements and RICH radius cuts made this study conditions much more cleaner.
- Calorimeters were energy calibrated using electron and hadron beam. EMCAL and HCAL responses found to be linear vs the incoming particle's energy.
- EMCAL and HCAL constants will be placed in ..offline/DSTAnalysis/DSTUtilcxx. User can have: a)raw ADC sum, b)energy value (GeV) with hadron hypothesis and c)energy value for given the particle's specie.
- EMCAL constants ratio for electrons over pions (e/π ratio) found to be about 0.8, which is quite good for this cheap design ($e/\pi \approx 1.4$ for iron calorimeter).
- Latest resolutions (σ/p) are better than what presented about 1 year ago. π^+ : 8.8% now and 11% before, p : 9.2% now and 12% before.
- We considering to submit an article to NIM